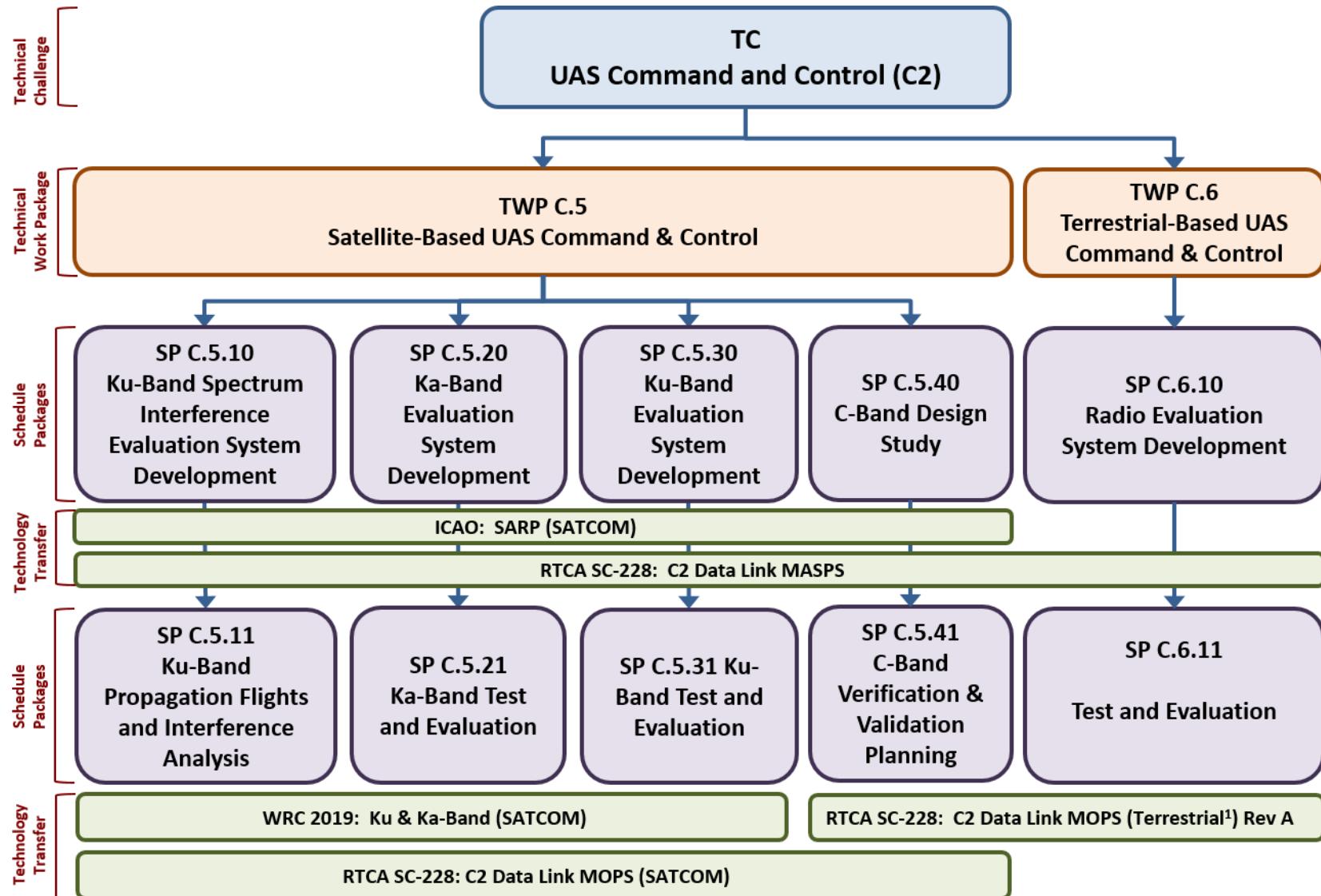






UAS-NAS C2 Subproject Overview

(FY17 – FY20)



Note 1: Study of shared Terrestrial and SATCOM C-Band spectrum

TC: Technical Challenge
TWP: Technical Work Package
MASPS: Minimum Aviation System Performance Standards

MOPS: Minimum Operational Performance Standards
SARP: Standards And Recommended Practices

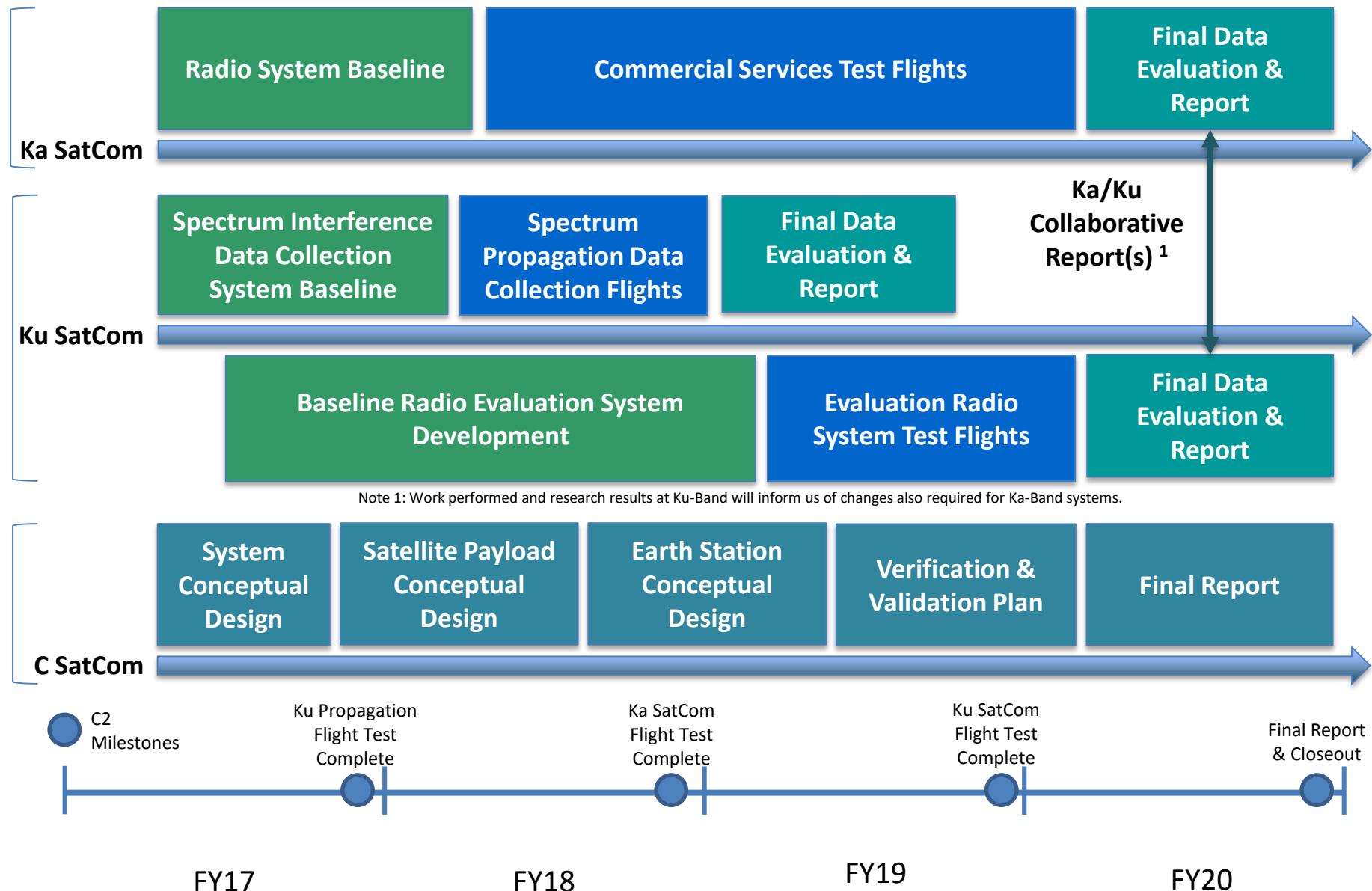


SatCom



UAS-NAS SatCom UAS C2 Task Overview

(FY17 – FY20)





Ka-Band SatCom UAS C2

NASA – Honeywell Cooperative Agreement

On Feb 27, 2017, NASA initiated a shared resource cooperative agreement with Honeywell to demonstrate and support the further development of a Ka-Band Unmanned Aircraft SatCom System.

- Deliver three (3) COTS JetWave Ka-Band terminals
- Supply airtime, support installation, and support service provisioning
- Support flight data analysis
- Support industry standards development



Ka-Band SatCom UAS C2

Ka-Band SatCom UAS C2

Testing of a COTS unit within established Commercial Services to develop requirements for UAS C2 SatCom MOPS in RTCA SC-228.

Performance variable:

- *Trade-off between Committed Information Rate (Quality of Service) Customer Service Plans.*
- *Other non-consumer variables may be possible through the partnership agreement with Honeywell.*



JetWave Ka-Band SatCom
Airborne Terminal
(Honeywell)

NASA GRC Flight Asset

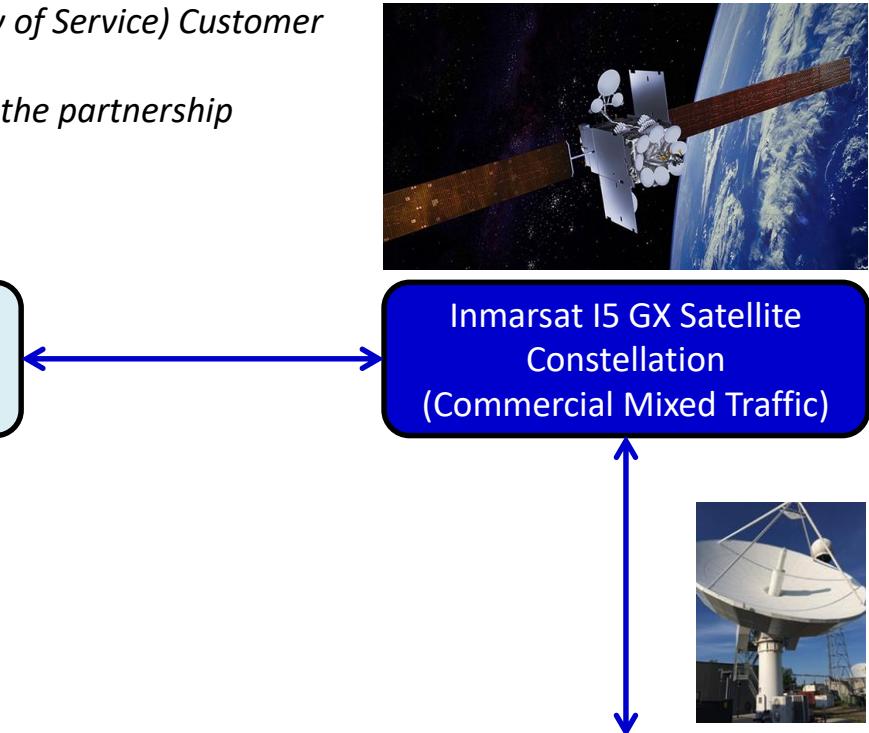


Inmarsat I5 GX Satellite
Constellation
(Commercial Mixed Traffic)



UAS Command & Control
Flight Test Control Center

*NASA GRC
Cleveland, OH*



Internet

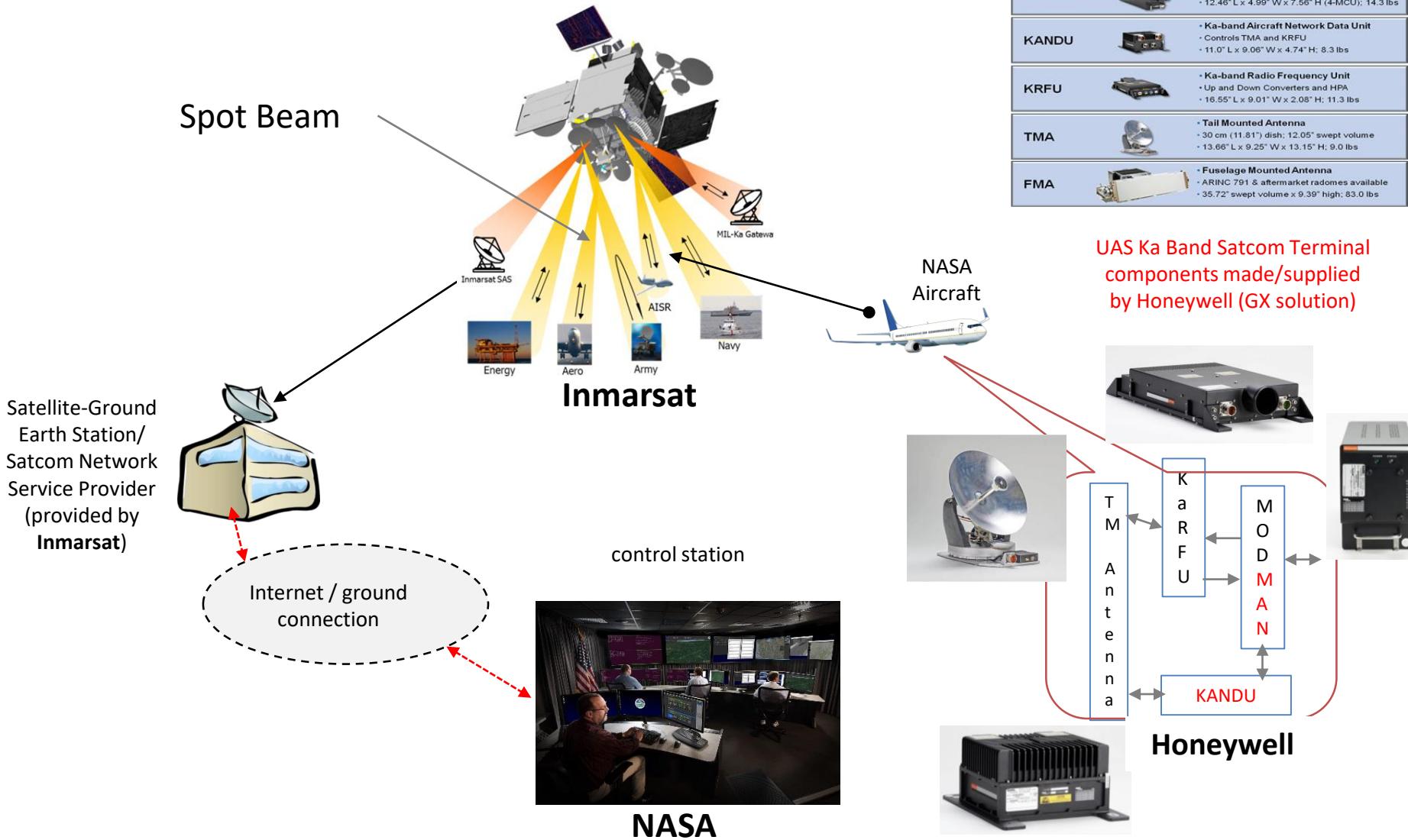
Internet



Inmarsat Satellite Gateway
(GX Commercial Services)



UAS Ka-Band SATCOM System





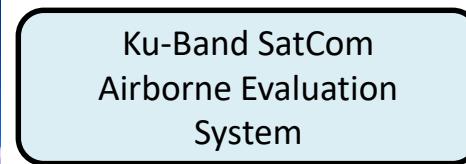
Ku-Band SatCom UAS C2

Ku-Band SatCom UAS C2

Development and evaluation of a “flexible” prototype unit and C2 test environment system to verify and validate the UAS SatCom MOPS being developed by RTCA SC-228.

Performance variables:

- *Transmit Power*
- *Receiver sensitivity*
- *Modulation*
- *Coding*
- *Data Rate*
- *Security Scheme*
- *Multiple Access Method*
- *TBD*



NASA GRC Flight Asset



Ku-Band Satellite

*Geosynchronous
Orbit*



UAS Command & Control
Flight Test Control Center

*NASA GRC
Cleveland, OH*

Fiber

NASA GRC Ku-Band
Satellite Gateway

*NASA GRC
Cleveland, OH*



Terrestrial



NASA – Rockwell Collins Cooperative Agreement

On Jan 10, 2017, NASA extended a shared resource cooperative agreement with Rockwell Collins to further demonstrate and support the development of a Terrestrial Unmanned Aircraft SatCom System.

- Perform trade study to determine changes from DO-362
 - Must be in compliance with DO-362 Compatibility Section 2.2.1
 - Lower altitude operational environment
 - More efficient waveform
 - Multiple access techniques
- Deliver eight (8) C-Band radios
 - Gen-6
 - Gen-7
- Support flight data analysis
- Support industry standards development



Terrestrial UAS C2 TWP Overview

Phase 1: FY12 – FY16

Relevant Environments

- Hilly Terrains
- Over Fresh Water
- Urban
- Desert
- Mountainous

Terrestrial

17,500 ft MSL

RF Sounding Flights @ 2,000 ft AGL

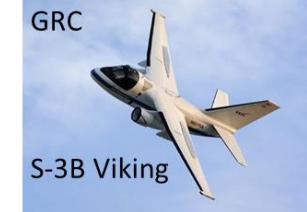
1,000 ft AGL

Flight Testing

Phase 2: FY17 – FY20

Relevant Environments

- TBD*



TBD* ft MSL

Phase 2 will focus on lower altitudes and higher UAS traffic density than considered in Phase 1

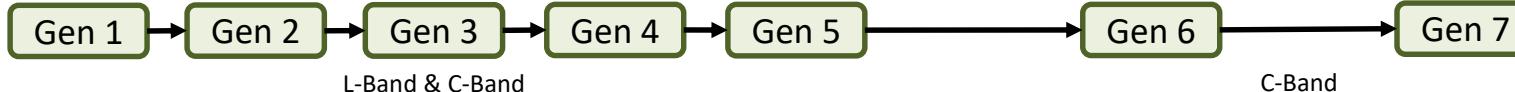
Terrestrial

500 ft AGL

Flight Testing

* Based on Phase 2 trade studies

Terrestrial Radio Development



Phase 2: FY17 – FY20

C2 Milestones

V 6.0
Radio

Flight
Test

V 7.0
Radio

Flight
Test

Final
Report

FY17

FY18

FY19

FY20



Backup



Ku-Band SatCom UAS C2 Interference Testing

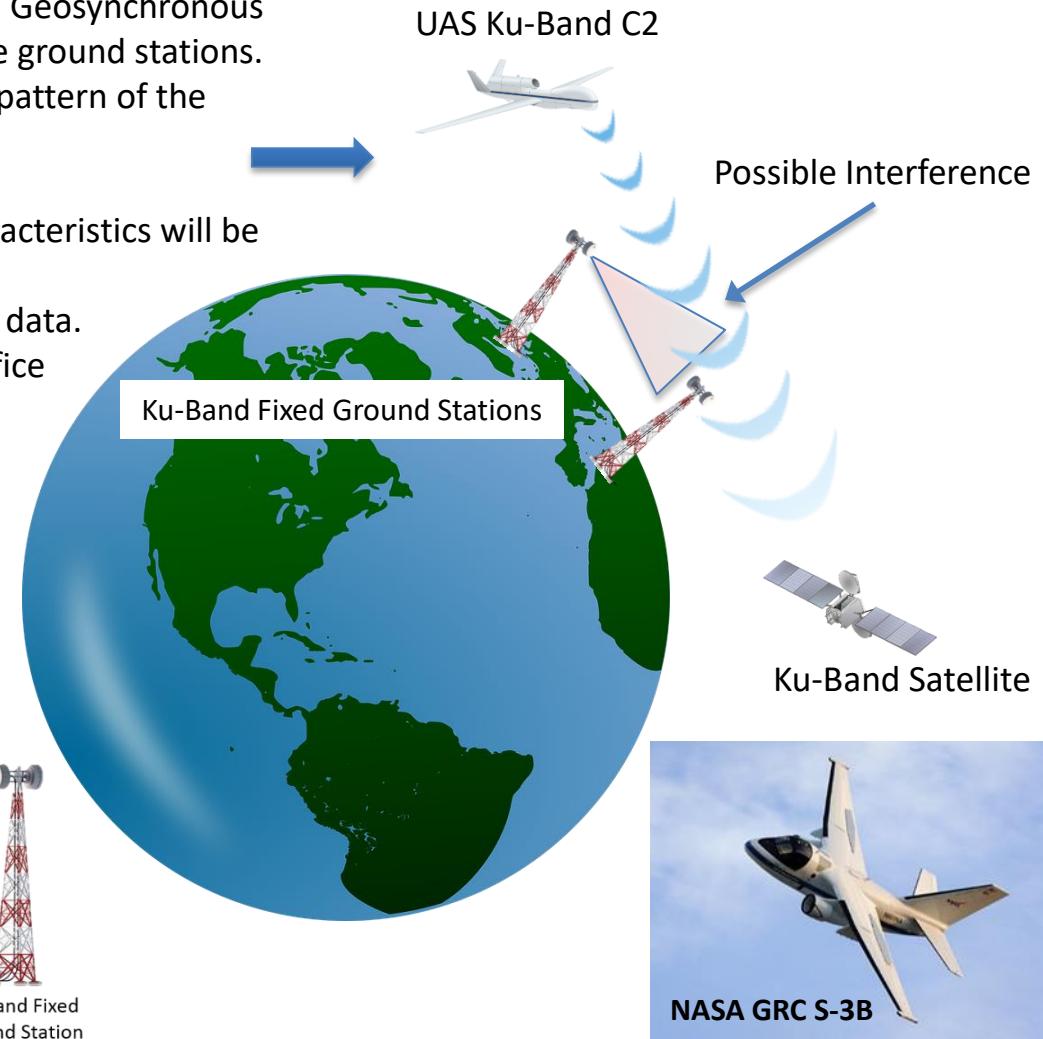
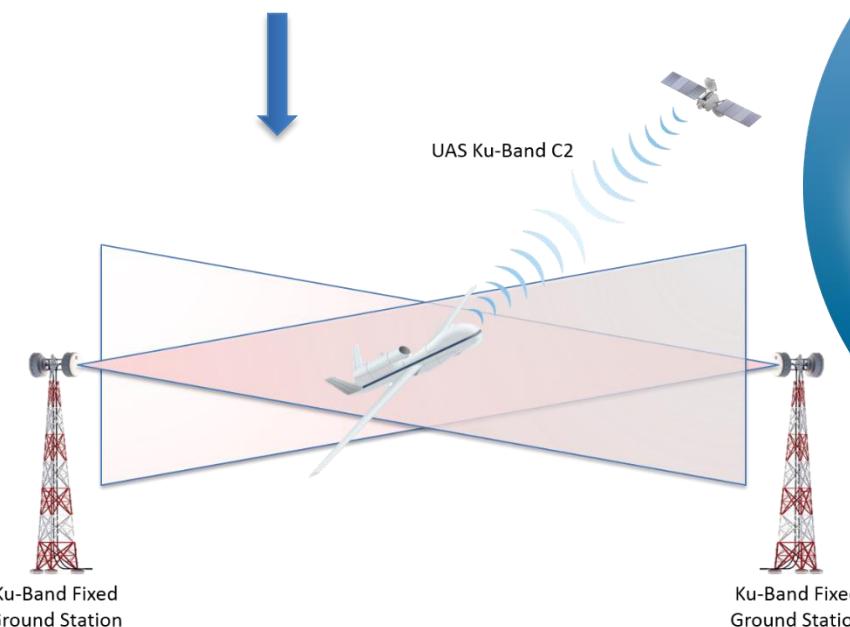
Possible interference zones of UAS Ku-Band C2 with Ku-Band Fixed Ground Stations (non-USA) will be researched.

Issue:

- C2 transmit signals at low elevation sight angles to Geosynchronous satellites may be within the antenna pattern of the ground stations.
- C2 antenna side lobes may be within the antenna pattern of the ground stations.

Approach:

- A representative test system with baseline RF characteristics will be developed.
- Flight tests will be executed to gather propagation data.
- Data will be given to SC-228 and FAA Spectrum Office



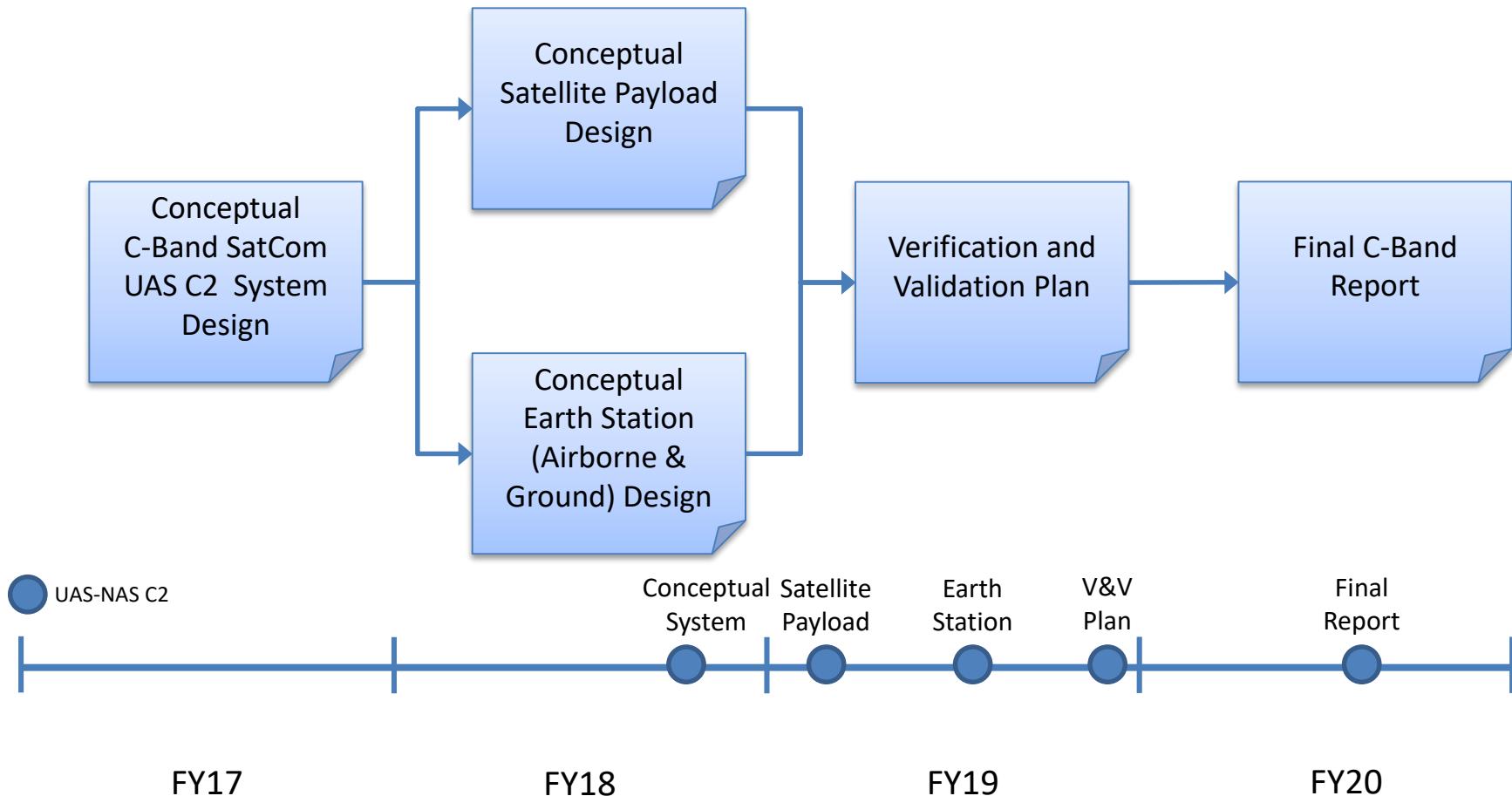


C-Band SatCom UAS C2 Task Overview

(FY17 – FY20)

C-Band SatCom UAS C2 Concept Design

- Results from C-Band SatCom studies will seed the development design parameters for a CNPC system in the allocated C-Band AMS(R)S frequency allocation in which no satellites currently operate.
- Feasibility of an operational C-Band satellite-based CNPC system will be studied.



Note 1: Will support the study of shared Terrestrial and SATCOM C-Band spectrum.